of Kara it was found completely free of ice! "Our course was set towards the middle of the peninsula which separates the Sea of Kara from the Bay of Obi, and is named Jalmal by the Samoyedes. The wind was very moderate, so that we only advanced slowly—a circumstance by which our patience was in truth sorely tried, but which had this good result, that during our sailing forward in these waters visited for the first time by a scientific expedition, we were able daily to undertake dredgings, hydrographic work, &c. The dredgings gave an unexpectedly rich and various harvest of marine animals, among which I will specially mention here several colossal species of Isopoda, masses of Amphipoda and Copepoda, a large and beautiful Alecto, uncommonly large Ophiurids, beautifully marked Asterids, innumerable mollusca, &c. The peculiar circumstance here occurs that the water at the surface of the sea, which in consequence of the great rivers which debouch in these regions is nearly free of salt, forms a deadly poison for the animals which live in the salt water at the bottom. Most of the animals brought up from the bottom accordingly die if they are placed in water from the surface of the sea.

"Here, as on the west coast of Novaya Zemlya, were instituted, when opportunity offered, with the thermometers by Negretti and Zambra and Casella procured by you during your stay in London last spring, determinations of the temperature of the sea, not only at the surface, but also at different depths under it. These investigations yielded a specially interesting result, and perhaps may be regarded as conclusive of a number of questions regarding which there has of late been much discussion concerning the ocean currents in these regions, the direction of which, in the absence of other data, it has been attempted to determine chiefly by the temperature of the surface water. By means of numerous observations along the west coast of Novaya Zemlya from Matotschkin Scharr to Jugor Sound, and thence past Cape Grebeni to $75\frac{1}{2}°$ N. lat. and 82° E. long., and on to the mouth of Jenisej, I have obtained indisputable proof that in this sea the temperature of the sea-water at the surface is exceedingly variable and dependent upon the temperature of the air, upon the neighbourhood of ice, and upon the influx of warm fresh water from Obi and Jenesej, but that the temperature of the water at a depth of only ten fathoms is nearly quite constant, between $-1°$ and 2° C. If, in the northern part of the Sea of Kara, where the water on the surface is almost completely *free of salt*, and at this time of the year very warm, a flask filled with water from the surface is sunk to a depth of ten fathoms, the water freezes to ice. There are thus no warm ocean currents here at any considerable depth below the surface. A large number of deep-water samples have been taken by the apparatus constructed by Prof. Ekman, which is exceedingly well adapted for the purpose, and I am convinced that at the bottom the content of salt is also constant, which can be ascertained with certainty after the return of the expedition by analyses of the samples of water which have been taken.

"On the 8th August we landed for a few hours on the north-western side of Jalmal, where an astronomical determination of the position of the place was made. A great many astronomical determinations had previously been made during the expedition along the west coast of Novaya Zemlya and Jugor Sound. Traces of men, some of whom had gone barefoot, and of Samoyede sledges, were visible on the beach. Close to the shore was found a sacrificial altar, consisting of about fifty skulls of the Ice Bear, Walrus, and Reindeer bones, &c., laid in a heap. In the middle of the heap of bones there stood, raised up, two idols, roughly hewn from drift-wood roots, newly besmeared in the eyes and mouth with blood, also two poles provided with hooks, from which hung bones of the Reindeer and Bear. Close by was a fireplace and a heap of Reindeer bones, the latter clearly a remnant of a sacrificial meal. After a stay here of several hours, I sailed further north, until further advance in this direction was prevented by impassable masses of great even icefields at 75° 30′ N. lat., and 79° 30′ E. long. Afterwards I followed the edge of the ice eastwards, and finally steered our course towards the north side of the mouth of Jenisej, where the Swedish flag was hoisted and the anchor was let go on the 15th in the afternoon. We had now attained the goal which great seafaring nations had in vain striven for centuries to reach.

"The expedition will now, in accordance with the plan agreed upon, separate, inasmuch as I, accompanied by Lundström and Stuxberg, and three men, intend, in a Nordland boat brought with us for the special purpose, to sail or row up the Jenisej, in order to return by Turuchansk and Jeneseisk to Europe, while the *Pröven* returns hence to Norway, if possible going north of the north point of Novaya Zemlya."

SCIENCE IN GERMANY

(*From a German Correspondent.*)

SINCE we possess in the kinetic molecular theory, as founded by Clausius, a mechanical theory based on the atomic conception of gases, it is possible to employ the results of the chemical investigation of these bodies for physical deductions. It is only necessary to suppose for this purpose that *the same* molecules, which are the bearers of the thermal and mechanical properties of gases, act reciprocally in chemical reactions. We must point out as one of the most important confirmations of this view, that Avogardo's hypothesis, based on general physical deductions, and adopted in chemistry as the foundation-stone of its whole recent development, has lately found its mechanical confirmation in the gaseous theory of Maxwell and of Boltzmann.

Recently, however, difficulties have arisen in the further investigation of this theory, with regard to the specific heat of gases. The quantity of heat contained in a gas is defined as the total energy of its molecules, and this energy consists solely in progressive motion, if the molecule is looked upon as a mere material point. On the other hand, the pressure of the gas upon the surface-unit equals two-thirds of the kinetic energy of progressive motion contained in the volume-unit. If, therefore, we raise the temperature of the gas by one degree, the volume remaining the same, we can find by calculation the adduced quantity of heat according to the gaseous theory, from the increase of pressure determined by Mariotte-Gay Lussac's law. This quantity of heat in its relation to the mass-unit, is, as is known, called the specific heat of the gas at the constant volume (c), and calculation now shows this value to be 0·60 of the observed one. In close connection with this it was found that the proportion of specific heat at constant pressure (c') to the specific heat at constant volume (c), viz. $\frac{c'}{c} = k$ is $= 1·67$ according to the theory mentioned, but $= 1·405$ according to observation.

Clausius has shown that the theoretical value of c is certainly increased, if we take into account that according to the results of chemical researches the molecules of the gases hydrogen, oxygen, and nitrogen are *not* material points, but polyatomic, and that they are thus capable of storing, as it were, a certain quantity of energy in the shape of motion relative to a centre of gravity. But when Boltzmann lately investigated the behaviour of polyatomic gas molecules according to mechanical principles, he found c for a diatomic gas (like hydrogen, oxygen, nitrogen) to be 1·22 times more than observation shows. He found by calculation $k = 1·33$, and this value is *smaller* than the actual one (1·405). We must remark here that the supposition of a number of atoms larger than

2 would decrease k still further, and here exists for the present an unsolved contradiction between experience and the theory in its present form.

Looking at this state of things, Herren Kundt and Warburg at Strasburg thought it advisable to investigate experimentally the simplest case which nature offers to us, viz. the case of a gas which, according to its chemical behaviour, is a monatomic one. Herr Baeyer pointed out to them that mercury gas was such a gas; they therefore undertook to determine the specific heat of mercury gas. Here a contradiction to the theory did *not* become apparent; the experiment has yielded exactly the value demanded by theory for a monatomic gas, viz., $K = 1{\cdot}67$. Thus it is proved that the molecule of mercury gas, with regard to its thermal and mechanical properties, behaves exactly like a material point. It is hardly necessary to remark that, with regard to other properties, it is not at all necessary that the same molecule should behave like a material point. Thus, for instance, one glance at the spectrum emitted by incandescent mercury gas, which is crossed by many bright lines, shows us at once that the molecule of the same, with regard to the light it emits, does certainly not behave like a material point.

With regard to the way in which the experiment was conducted, we confine ourselves to the following remarks.

The k for mercury gas was determined from the velocity of sound in this gas, and this was found by means of the method of dust figures, formerly described by Herr Kundt.* A glass tube A, closed at both ends, well dried and pumped perfectly free from air, contained a certain quantity of mercury, which had been carefully weighed, and a little silicic acid. Sealed to this tube was another one, B (this a little narrower), in such a manner as to form the prolongation of A. A was placed in a four-fold box made of iron plates, which was heated by a series of Bunsen burners. This box also contained the great reservoir of an air thermometer, and, if observations were made at a temperature under 354°, several mercury thermometers besides. The end of B, projecting from the box, was sealed up, and over this end a long wide glass tube D was placed, which was closed at one end and contained a little lycopodium.

If now, after the necessary regulation in the heating arrangements, the thermometers in the box showed equal and sufficiently elevated temperatures, the tube composed of A and B was sounded by friction to its third longitudinal tone; at the same time a reading of the air thermometer was taken, and the temperature of the air in D was noted down. The powders introduced then showed in tubes A and D the sound-waves in mercury gas and in air respectively, so that afterwards the lengths of these waves could be measured with the greatest accuracy.

Let us suppose

l to be the length of the sound-wave in air,
l' ,, ,, ,, in mercury-gas,
t the absolute temperature of air in D,
t' ,, ,, of mercury gas in A,
$d = 6{\cdot}9783$ the density of mercury gas (air = 1),
k – the proportion $\frac{c'}{c}$ of the two specific heats for air.
k' ,, ,, ,, ,, for mercury gas.

Then we have

$$k' = k\left(\frac{l'}{l}\right)^2 \frac{t'}{t}\, d.$$

If k for air was taken at $= 1{\cdot}405$ according to Röntgen, then by seven definite experiments, at different degrees of saturation of the mercury vapour, and three different sets of apparatus being employed, it was found on the average that

$$k' = 1{\cdot}67.$$

The results of the different experiments never deviated more than one per cent. from this value.

* See NATURE, vol. xii, p. 88.

If the specific heat c at constant volume for air is taken as $= 1$, then it follows that c for mercury

$$c = 0{\cdot}60.$$

W.

AMONG THE CYCLOMETERS AND SOME OTHER PARADOXERS

NO notes have been handed down of the conversation between Erskine and Boswell, whilst strolling in Leicester Fields, on squaring the circle. There is on record, however, Boswell's small joke, "Come, come, let us circle the square, and that will do us good."

The subject is one that has occupied the thoughts of some few from the earliest times of geometrical history, and there are some now fascinated by it at this date, when we have—

> "on the lecture slate
> The circle rounded under female hands
> With flawless demonstration."

Old Burton advises him that is melancholy to calculate spherical triangles, square the circle, or cast a nativity. A popular novelist ("Aurora Floyd," chap. iv.), describing one of her characters "who was an inscrutable personage to his comrades of the 11th Hussars," says he was, "according to the popular belief of those harebrained young men, employed in squaring the circle in the solitude of his chamber."

To say of a man that he is a circle-squarer will make an ordinary mathematician shrug up his shoulders and indicate expressively that there is, in his opinion, a screw loose somewhere. Having had some slight acquaintance with the writings of a few of the race forced upon us, we propose here to pass them under review, generally contenting ourselves with letting them speak for themselves, for thus shall we possibly most effectually confute their absurdities, at least in the judgment of our mathematical readers.

De Morgan, the great exposer of circle-squarers, trisectors, *et id genus omne*, has, after Montucla, stated ("Budget of Paradoxes," p. 96) that there still exist three ideas in the heads of this race—(1) That there is a large reward offered for success; (2) that the longitude problem depends on that success; and (3) that the solution is the great end and object of Geometry. Some eight years ago we saw a letter from a Spanish Don of La Mancha, who offered to send an infallible method of squaring the circle; and within the last four months an application came to us from Sweden, in which the author stated that he had heard that the London Mathematical Society had offered a prize for the trisection of angles, and as he had after long working at the problem obtained a solution, he was ready to transmit the same, but his organ of caution led him to fear lest his communication might get into improper hands, and so he wished to know to whom to send the aforesaid solution. We need hardly say that the Society, in this matter imitating the example of the French Academy of Sciences and of our own Royal Society, has declined to receive any communication upon either of the above-named subjects or upon that of the allied problem, the Duplication of the Cube. This decision was arrived at in consequence of a bulky mass of papers on the circle problem having been laid before the President in the end of 1871. The author had previously submitted his papers to our own examination, and after some little perplexing we were able to indicate the point at which the author had tripped. We have heard nothing further of the solution, nor seen any of the elaborate figures since. We think it fair to state that we believe this cyclometer to have been an honest man and a good geometer. He had worked at the problem, off and on, some twenty years, and attacked it by the lunes of Hippocrates of Chios.

We have consulted the "Introductorium Geometricum" of Charles de Bovelles (Bovillus) in the 1503,